# Sanford Underground Research Facility Lab Update

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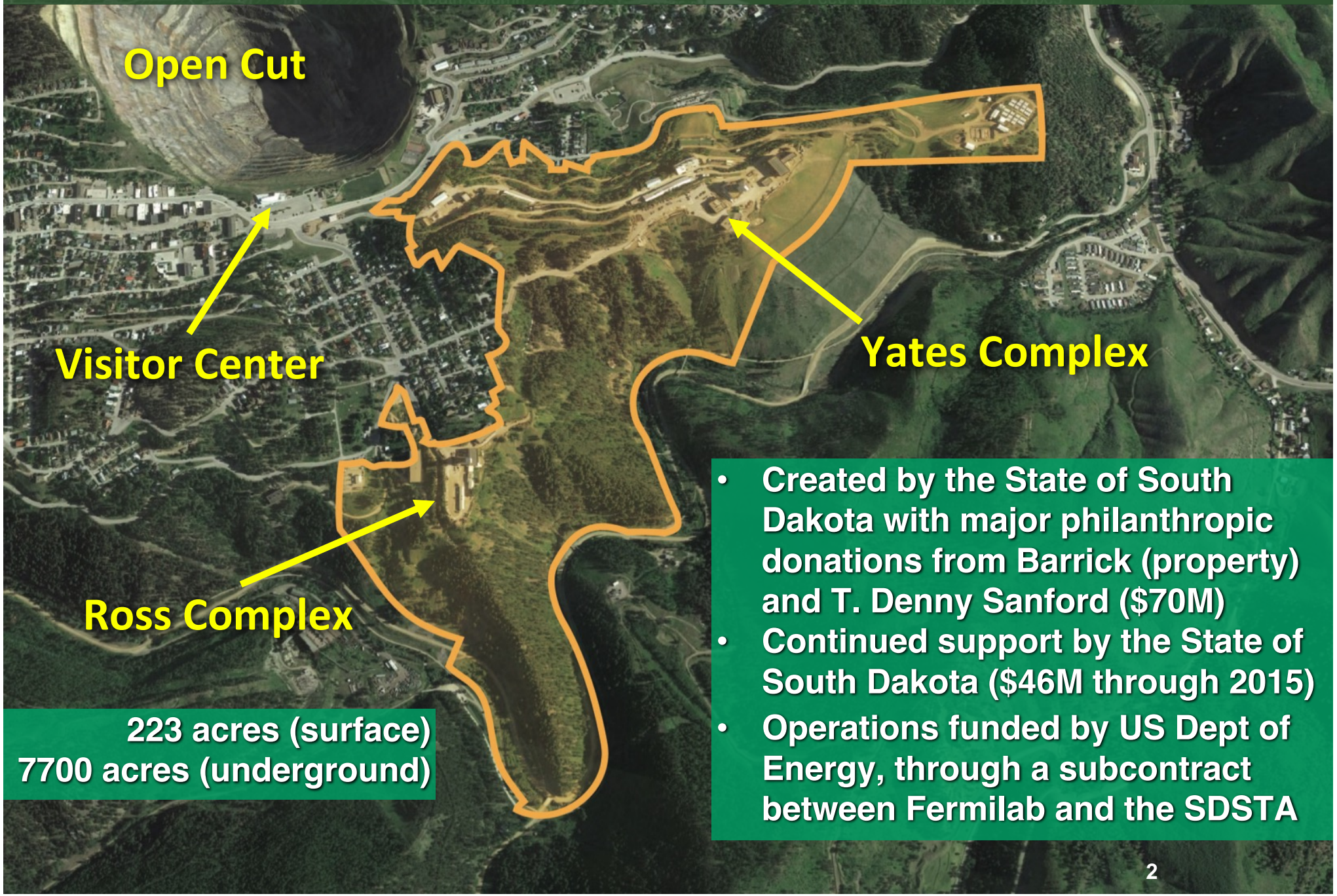
January 2018

Sanford Underground Research Facility
South Dakota Science and Technology Authority

# Sanford Underground Research Facility

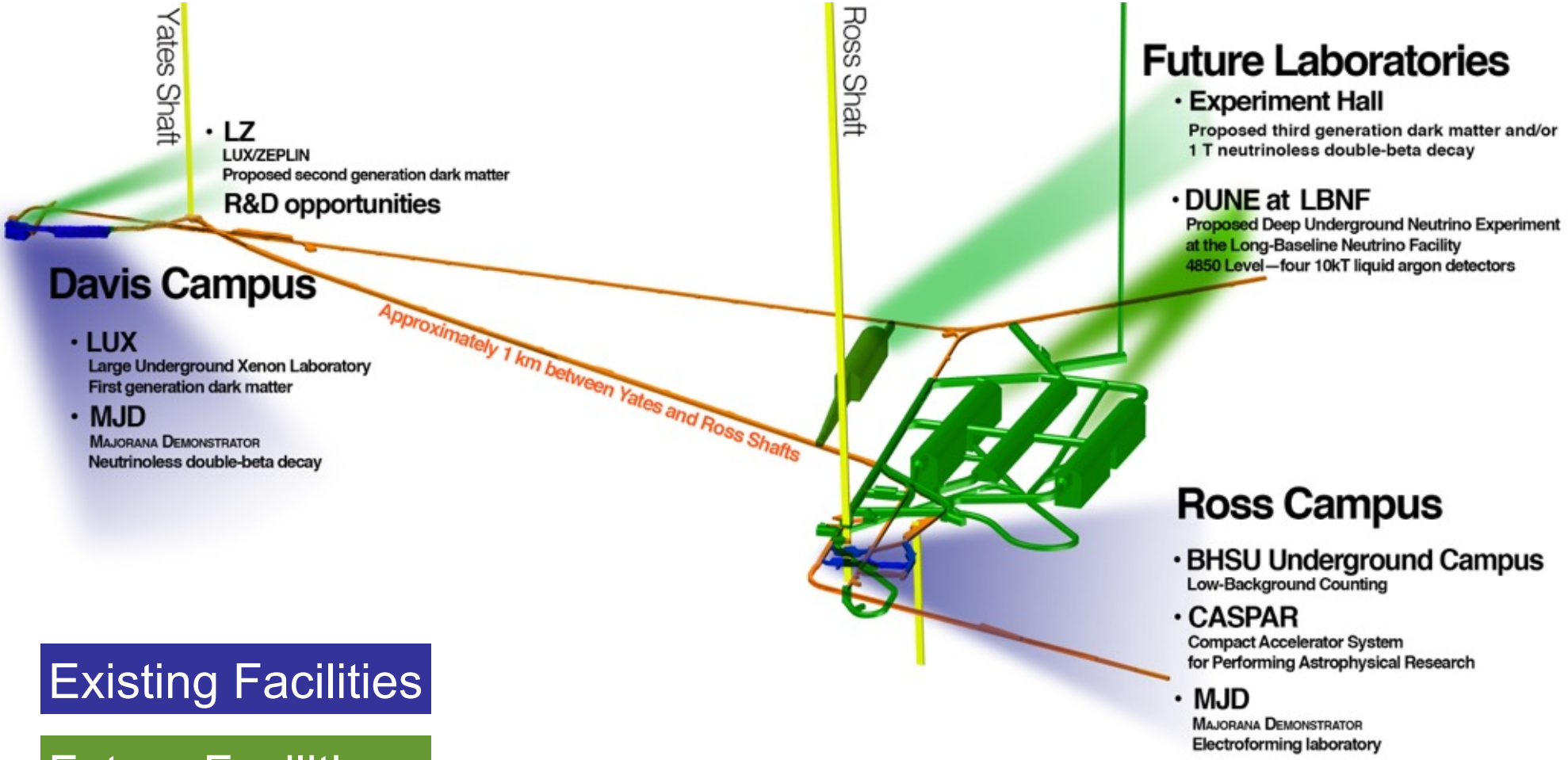
**Dedicated facility for underground scientific research**




223 acres (surface)
7700 acres (underground)

- Created by the State of South Dakota with major philanthropic donations from Barrick (property) and T. Denny Sanford ($70M)
- Continued support by the State of South Dakota ($46M through 2015)
- Operations funded by US Dept of Energy, through a subcontract between Fermilab and the SDSTA

# 4850L Science Facilities




Existing Facilities

Future Facilities

# Underground Physics Program

## MAJORANA DEMONSTRATOR (MJD):

- Studying the neutrino's mass and the matter/antimatter imbalance in the universe. Proving the techniques needed for a tonne-scale experiment.
- 2 cryostats with 44 detectors (40kg Ge) assembled. Physics data collection is underway.

## Large Underground Xenon (LUX):

- Direct detection of dark matter.
- Data taking completed in May 2016. Remains one of the most sensitive experiments in world.
- Decommissioning completed in prep for the LUX-ZEPLIN (LZ) next generation experiment.

# Underground Physics Program

## Compact Accelerator System for Performing Astrophysical Research (CASPAR):

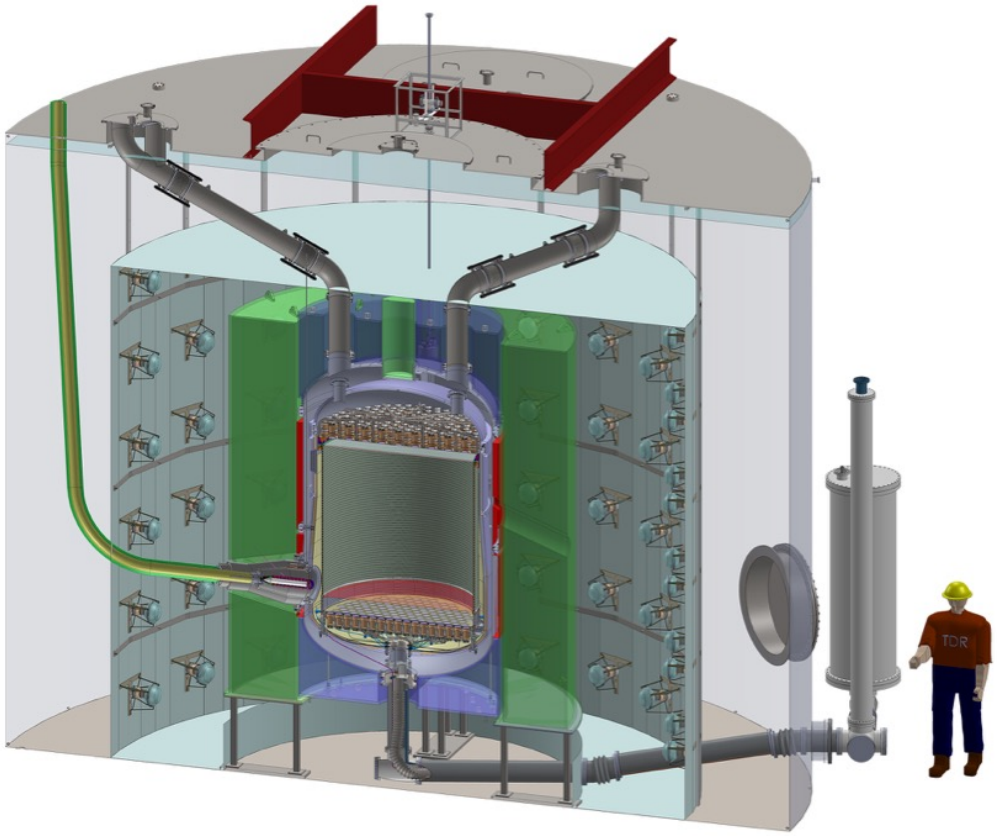
- Studying nuclear reactions in stars resulting in the generation of elements heavier than Fe.
- SDSM&T faculty and students leading assembly and commissioning process.
- “First beam” achieved in July 2017. Planning first physics data in early 2018.


## Black Hills State University (BHSU) Underground Campus (BHUC):

- Low background counting to characterize radiopurity of detector components.
- Installed 4 low background counters.
- Near term activities focused on the LZ dark matter experiment equipment.
- Providing opportunities for undergraduates in physics and other science disciplines.

# LUX-ZEPLIN (LZ) Dark Matter Experiment

## LZ will be located in the Davis Cavern on the 4850 foot level

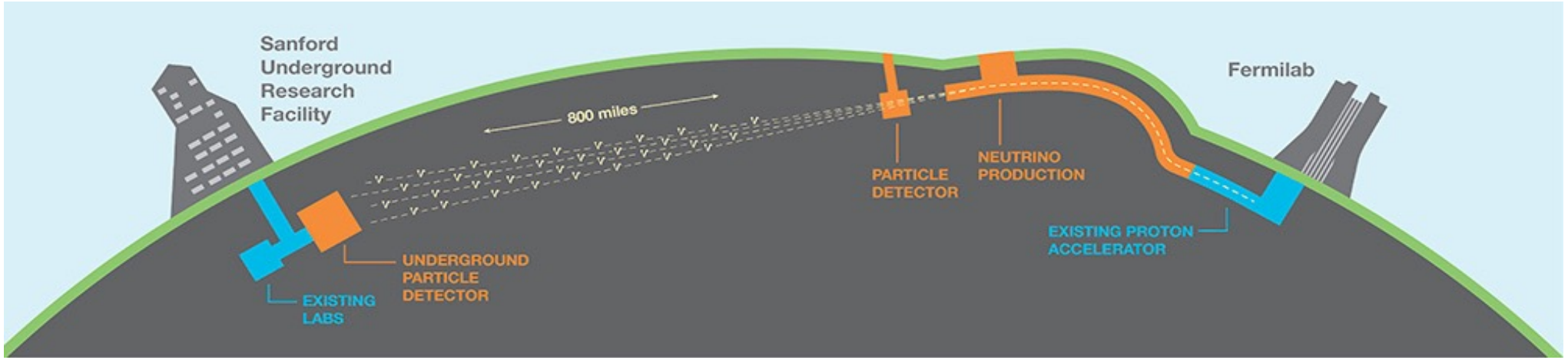


LZ Detector and Shielding

- LZ collaboration includes ~220 members at 36 institutions.
- 10,000 kg Xe (3,500 gallons). 30x larger, 100x more sensitive than LUX.
- Using existing Surface Laboratory and 4850L Davis Campus facilities.
- Project has been “baselined” by DOE.
- Surface facility upgrades completed.
- Underground work to start Jan 2018.
- Experiment installation in 2018-19.
- Operate for 5 years starting ~2020.

# Long-Baseline Neutrino Facility (LBNF)

## LBNF will host the Deep Underground Neutrino Experiment (DUNE)




- **The first internationally conceived, constructed, and operated mega-science project hosted by the Department of Energy in the United States.**
- Project led by Fermilab with significant international contributions (including CERN).
- DUNE collaboration includes 1000+ scientists from 176 institutions and 31 nations.
- Four DUNE detectors planned at SURF with 70kT liquid argon total (13 million gallons).
- DOE approved construction of SD facilities in Sept 2016. FY2017 appropriation of $50M for construction start, which sent a strong, positive signal to international collaborators.
- Construction in South Dakota to start spring 2018. Excavation expected in mid-2019.
- Fermilab has a Construction Manager under contract - Kiewit Alberici Joint Venture.
- LBNF/DUNE construction expected to last 10 years. Experiment will operate for 20+ years.

# Educational Opportunities for K-12 Students

## School Presentations

**Elementary**
- A Day in the Life…
- Particle Accelerators

**Middle School**
- Career Opportunities
- Dark Matter

**High School**
- Neutrinos

## Curriculum Units

**Early Elementary**
- Creature Features
- Between a Rock and a Dark Place

**Elementary**
- Exploring Unseen
- Force Be With You
- There & Back Again

**Middle School**
- Seismic Science
- Search Dark Matter
- Waterworks

**High School**
- Perplexing Puddles
- Star-Stuff

## Field Trips

**Opportunities to visit the lab are limited. School visits available:**
- Fall
- Spring

# E&O Curriculum Units

# E&O Student Impact - Numbers in Review

- 2016-2017 School Year
  - Students at field trips - 692
  - Students at classroom talks - 8,651
  - Students using curriculum units - 3,243
- Summer 2017
  - Teachers at summer workshops - 54
- Over the last two years
  - Students at field trips - 1,355
  - Students at classroom talks - 17,229
  - Students using curriculum units - 4,161
  - Teachers at summer workshops - 112

# Economic Impacts in South Dakota

**Through September 2017 (end of U.S. Federal FY2017)**

| | |
|---|---|
| **Spending in South Dakota to date** | **$185 million** |
| FY18 total budget (all sources & activities) | $22.9 million |
| FY18 SURF Operations budget (DOE funds) | $14.6 million |
| Annual payroll budget in SD (FY18) | $13.3 million |
| Annual non-payroll budget in SD (FY18) | $6.7 million |
| Jobs in South Dakota | 158 |
| Active research groups | 23 |
| Research groups with SD members | 18 |

# Total Spending in South Dakota through Sept 30, 2017

## Grouped by 3-digit zip code region